RS-002, "PROCESSING APPLICATIONS FOR EARLY SITE PERMITS"

ATTACHMENT 2

2.4.2 FLOODS

REVIEW RESPONSIBILITIES

Primary - Mechanical and Civil Engineering Branch (EMEB)

Secondary - None

I. AREAS OF REVIEW

This section of the site safety assessment for an early site permit (ESP) application identifies historical flooding (defined as occurrences of abnormally high water stage or overflow from a stream, floodway, lake, or coastal area) at the proposed site or in the region of the site. It summarizes and identifies the individual types of flood-producing phenomena, and combinations of flood-producing phenomena, considered in establishing the flood design bases for safety-related features for a nuclear power plant or plants of specified type (or falling within a plant parameter envelope [PPE]) that might be constructed on the proposed site. It also covers the potential effects of local intense precipitation. Although topical information may appear in safety assessment Sections 2.4.3 through 2.4.7, the types of events considered and the controlling event are reviewed in this section.

The flood history and the potential for flooding are reviewed for the following sources and events. Factors affecting potential runoff (such as urbanization, forest fire, or change in agricultural use), erosion, and sediment deposition are considered in the review.

1. Stream flooding

    a. Probable maximum flood (PMF) with coincident wind-induced waves, considering dam failure potential due to inadequate capacity, inadequate flood-discharge capability, or existing physical condition.

    b. Ice jams, both independently and coincident with a winter probable maximum storm.

    c. Tributary drainage area PMF potential.

    d. Combinations of less severe river floods, coincident with surges and seiches.

2. Surges

    a. Probable maximum hurricane (PMH) at coastal sites.

    b. PMH wind translated inland and resulting wave action coincident with runoff-induced flood levels.

c. Probable maximum wind-induced (non-hurricane) storm surges and waves.

d. Combinations of less severe surges, coincident with runoff floods.

3. Seiches

a. Meteorologically induced in inland lakes (e.g., Great Lakes and harbors) and at coastal harbors and embayments.

b. Seismically induced in inland lakes.

c. Seismically induced by tsunami (seismic sea waves) on coastal embayments.

d. Combinations of less severe surges and seiches, coincident with runoff floods.

4. Tsunamis

a. Near field, or local, excitation.

b. Far field, or distant, excitation.

5. Seismically induced dam failures (or breaches) and maximum water level at site from:

a. Failure of dam (or dams) during safe shutdown earthquake (SSE) coincident with 25-year flood.

b. Failure during an earthquake equal to ½ the SSE coincident with standard project flood (SPF).[1]

c. Failure during other earthquakes, coincident with runoff, surge, or seiche floods where the coincidence is at least as likely as for 5.a and 5.b above.

6. Flooding caused by landslides

a. Flood waves.

b. Backwater effects due to stream blockage.

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[1] This combination is based on the guidance of Regulatory Guide 1.59, "Design Basis Floods for Nuclear Power Plants" and past NRC licensing practice. Regulatory Guide 1.59 references ANSI Standard N170-1976, which has been superseded by ANSI/ANS-2.8-1992, "American National Standard for Determining Design Basis Flooding at Power Reactor Sites." Section 9.2.1.2 of this standard calls for consideration of dam failure caused by the Operating Basis Earthquake (OBE) coincident with the peak of flood. Existing reactors were licensed using an OBE equal to ½ the SSE. Though a 1997 rulemaking eliminated use of the OBE in reactor design, the value of ½ the SSE (or other value if justified by an ESP applicant) may be used to analyze seismically induced dam failures.

7. Ice loadings from water bodies

II. ACCEPTANCE CRITERIA

Acceptance criteria for this section of this review standard address 10 CFR Parts 52 and 100 (Refs. 1 and 2) as they relate to identifying and evaluating hydrologic features of the site. The regulations at 10 CFR 52.17(a) and 10 CFR 100.20(c) require that the site's physical characteristics (including seismology, meteorology, geology, and hydrology) be taken into account when determining its acceptability to host a nuclear reactor or reactors.

To satisfy the hydrologic requirements of 10 CFR Parts 52 and 100, the applicant's safety assessment should contain a description of the surface and subsurface hydrologic characteristics of the site and region and an analysis of the PMF. This description should be sufficient to assess the acceptability of the site and to assess the potential for those characteristics to influence the design of plant structures, systems, and components important to safety. Meeting this requirement provides reasonable assurance that the hydrologic characteristics of the site and potential hydrologic phenomena would pose no undue risk to the type of facility proposed for the site.

For those cases where a reactor design is not specified, the ESP applicant may instead provide a PPE to characterize a facility or facilities for comparison with the hydrologic characteristics of the site. A PPE can be developed for a single type of facility or a group of candidate facilities by selecting the limiting parameters from among the group. Important PPE parameters for safety assessment Section 2.4 include but are not limited to precipitation (e.g., maximum design rainfall rate and snow load) and the allowable site water level (e.g., maximum allowable flood or tsunami and maximum allowable ground water level).

Note: Though not required at the ESP stage, the applicant for a combined license (COL) will need to demonstrate compliance with General Design Criterion 2 (Ref. 3) as it relates to structures, systems, and components important to safety being designed to withstand the effects of hurricanes, floods, tsunamis, and seiches.

To meet the requirements of the hydrologic aspects of 10 CFR Parts 52 and 100, the following specific criteria are used:

For safety assessment Section 2.4.2.1 (Flood History): The potential flood sources and flood response characteristics of the region and site identified by the staff's review (described in Review Procedures) are compared to those of the applicant. If similar, the applicant's conclusions are accepted. If, in the staff's opinion, significant discrepancies exist, the applicant will be requested to provide additional data, reestimate the effects on a nuclear power plant or plants of specified type (or falling within a PPE) that might be constructed on the proposed site, or revise the applicable flood design bases, as appropriate.

For safety assessment Section 2.4.2.2 (Flood Design Considerations): The applicant's estimate of controlling flood levels is acceptable if it is no more than 5% less conservative than the staff's independently determined (or verified) estimate. If the applicant's safety assessment estimate is more than 5% less conservative, the applicant should fully document and justify its estimate of the controlling level. On the other hand, the applicant may accept the staff's estimate.

For safety assessment Section 2.4.2.3 (Effects of Local Intense Precipitation): The applicant's estimates of local probable maximum precipitation (PMP) and the capacity of site drainage facilities (including drainage from the roofs of buildings and site ponding) are acceptable if the estimates are no more than 5% less conservative than the corresponding staff's assessment. Similarly, conclusions relating to the potential for any adverse effects of blockage of site drainage facilities by debris, ice, or snow should be based upon conservative assumptions of storm and vegetation conditions likely to exist during storm periods. If a potential hazard does exist (e.g., the elevation of ponding exceeds the elevation of plant access openings), the applicant should document and justify the local PMP basis. At the COL stage, the applicant should analyze and design affected facilities to ensure they are protected against PMP.

Appropriate sections of the following documents are used by the staff to determine the acceptability of the applicant's data and analyses in meeting the requirements of 10 CFR Parts 52 and 100. Regulatory Guide 1.59[2] (Ref. 4) provides guidance for estimating the design basis flooding considering the worst single phenomenon and combinations of less severe phenomena. Publications of the U.S. Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA), Soil Conservation Service (SCS), Corps of Engineers, applicable State and river basin authorities, and other similar agencies are used to verify the applicant's data relating to hydrologic characteristics and extreme events in the region. Sections 2.4.3 through 2.4.7 of this review standard discuss methods of analysis to determine the individual flood-producing phenomena.

III. REVIEW PROCEDURES

Requirements and procedures governing issuance of ESPs for approval of proposed sites for nuclear power facilities are specified in 10 CFR Part 52. Information necessary for such a permit includes a description of the site's flood-related hydrologic characteristics. (Ref. 6) For this type of permit, the scope and level of detail for reviewing hydrologic data are outlined below.

ESP reviews are carried out under this section of this review standard to evaluate the significance of the controlling flood level with regard to the design basis for flood protection of a nuclear power plant or plants of specified type (or falling within a PPE) that might be constructed on the proposed site.

For safety assessment Section 2.4.2.1 (Flood History):

The staff will review publications of the U.S. Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA), Soil Conservation Service (SCS), Corps of Engineers, applicable State and river basin agencies, and others to ensure that historical maximum events and the flood response characteristics of the region and site have been identified. Similar material, in addition to applicant-supplied information, will be reviewed to identify independently the potential sources of site flooding.

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[2] In using Regulatory Guide 1.59, references to ANSI N170-1976 should be read as references to ANSI/ANS-2.8-1992 (Ref. 5), which has superseded the earlier document.

The potential flood levels from consideration of the worst single phenomenon and combinations of less severe phenomena are identified in accordance with Sections 2.4.3 through 2.4.7 of this review standard and the controlling flood level is selected. The controlling flood level is compared with the proposed protection levels to ensure that the safety-related facilities for a nuclear power plant or plants of specified type (or falling within a PPE) that might be constructed on the proposed site will not be adversely affected. If appropriate, additional provisions for flood protection will be imposed to ensure adequate protection of safety-related facilities.

For safety assessment Section 2.4.2.3 (Effect of Local Intense Precipitation):

The staff's estimates of flooding potential are based on PMP estimates from the appropriate hydrometeorological reports and similar NOAA publications. The staff's estimates are compared with the applicant's estimates to determine conformity to Acceptance Criteria in subsection II of this section of the review standard. Runoff models, such as the unit hydrograph if applicable, or other runoff discharge estimates presented in standard texts, are used to estimate discharge on the site drainage system. Where generalized runoff models are used, coefficients used for the site and region are compared to information available at documented locations to evaluate hydrologic conditions used in determining the probable maximum flood for the site drainage system. Potential ponding on the site is also determined.

The above reviews are performed only when applicable to the site or site region. Some items of review may be done on a generic basis.

IV. EVALUATION FINDINGS

For ESP reviews, the findings will consist of a statement indicating the completeness of the identification of site flood characteristics and flood design bases in compliance with 10 CFR Parts 52 and 100. Sample statements for an ESP review follow:

> The maximum flood known to have occurred on the A River was in 1796. The peak discharge at B City, Montana, was estimated to be 10,200 m^3/s (360,000 cubic feet per second (cfs)). The applicant estimated that a comparable flood would produce water surface elevation at the site of 35.4 m (116 ft) MSL. The maximum flood during the period since records were maintained (1883) at B City was 9,900 m^3/s (350,000 cfs) and occurred on October 3, 1929. These floods occurred prior to construction of several upstream dams. Flood flows are now regulated by C and D Reservoirs as well as by upstream hydropower plants.
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> The applicant has estimated potential flooding from rainfall over the E River basin upstream from the site. The probable maximum flood (PMF), the upper level of flooding the staff considers to be reasonably possible, was estimated to produce a flow of 140,000 m^3/s (5,000,000 cfs) near the city of F. This estimate was made by using 165% of the Corps of Engineers project design flood (PDF) estimate of 85,800 m^3/s (3,030,000 cfs) at the same location, as modified by upstream flood control reservoirs.

The 85,800-m^3/s (3,030,000-cfs) project design flood flow is estimated to be partially diverted to the leveed G and H Floodways upstream of the site, with 42,500 m^3/s (1,500,000 cfs) continuing downstream within the levee system past the plant site. The applicant concluded that the PMF could result in overtopping of levees and flooding of the river valley well upstream from the site, thereby causing generally low level flooding in the site area. The upstream levee overtopping and resulting valley flow during such an event would reduce the flow in the main levee channel adjacent to the site to levels equal to or less than those that would exist during a project design flood.

The staff concludes that the combination of a runoff-type flood less severe than a PMF, but more severe than a PDF, and a coincident levee break in the vicinity of the site could occur before water approaches levee grade upstream. A failure or levee breach, when the levee is full to design capacity [1 m or 3 ft] below the top of the levee adjacent to the site plus the effects of any coincident wind-generated wave activity), would result in a higher water surface at the plant site than a PMF spread over the valley as a result of levee failures upstream. At the staff's request, the applicant evaluated various modes of levee failure in the vicinity of the site.

One of the conditions postulated is that of a flood, approaching the severity of a PMF, causing a massive failure of the upstream left bank levee along the G floodway, resulting in flooding around the site, coincident with a failure of the levee adjacent to the site. The applicant estimated the resulting water level at the site would reach elevation 6.9 m (22.5 ft) MSL for this case. The case of an instantaneous levee failure adjacent to the site, with no upstream levee failure, resulted in an estimated water level of 7.5 m (24.6 ft) MSL.

Based on this evaluation, the staff concludes that, in order to meet the requirements of 10 CFR Parts 52 and 100 with respect to potential hydrologic events, the applicant should design for the conditions associated with the 7.5-m (24.6-ft) MSL water level.

V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the NRC staff's plans for using this section of this review standard.

This section will be used by the staff when performing safety evaluations of ESP applications submitted by applicants pursuant to 10 CFR Part 52. Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission regulations.

Implementation schedules for conformance to parts of the method discussed herein are contained in the referenced regulatory guides.

VI. REFERENCES

Because of the geographic diversity of plant sites and the large number of hydrologic references, no specific tabulation is given here. In general, maps, papers, and charts by the U.S. Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA), Soil Conservation Service (SCS), Corps of Engineers; and other publications of state, federal, and other regulatory bodies, describing hydrologic characteristics and water utilization in the site vicinity and region, are referred to on an “as-available” basis.

1. 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants."

2. 10 CFR Part 100, "Reactor Site Criteria.”

3. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena.”

4. Regulatory Guide 1.59, "Design Basis Floods for Nuclear Power Plants."

5. ANSI/ANS-2.8-1992, “Determining Design Basis Flooding at Power Reactor Sites."

6. Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants."